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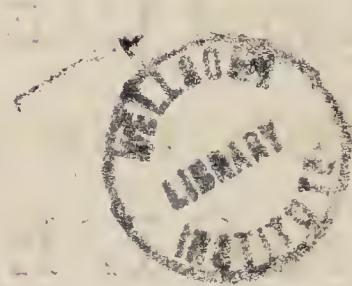
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A
SHORT ACCOUNT
OF THE
Nature and Use of Spectacles.

MY Design in the following Tract is to explain the Structure of the Eye, and the Nature of Vision, so far as is necessary to understand the Use and Advantage of Spectacles. The Method of chusing the best Sort of Glasses, and such as are suitable to the different Defects of the Eye in different Persons ; and to recommend a Kind of Glass, for this Purpose, much preferable to any that has been hitherto made use of.

The Nature of Vision, and Use of Spectacles, will be best explain'd, by the common Experiment of the dark Room, or as it is usually called the *Camera Obscura*, which is this. In any Room that is pretty much darken'd, let an Hole be made in the Win-

dow-Shutter, in which Hole place a convex Lens, or round globular Glass ; then holding a Sheet of white Paper within the Room, at a proper Distance from the Hole, (which you will find by Tryals) you will see on the Paper the Pictures of all Objects before the Hole, both in their just Proportions, and in their proper Colours, only they will be upside down. If the Paper remain in the same Place, and in the Room of the aforesaid convex Glass, or Lens, one that is flatter be used, the Picture upon the white Paper will then be confused ; but by placing a convex Spectacle-Glass before the Lens of a due Convexity, the Image on the Paper will again be render'd distinct. If a more convex Lens than the first be used, the Image on the Paper will again be confus'd, but may be render'd distinct, by placing in this case a concave Spectacle-Glass before the Lens.

This Experiment exactly represents the Manner of Vision by the Eye ; for the Eye is of a globular or convex Form, resembling the Lens plac'd in the Hole in the Window-Shutter, the outside Coat of which is call'd the *Cornea*, and gives the convex Shape to the aqueous or watery Humour contain'd within it : On the Bottom of the Eye is expanded a fine Membrane call'd the *Retina*, which

resembles

resembles the white Paper mention'd in the Experiment; on this Membrane the Pictures of all external Objects are form'd. When the Pictures are form'd distinct on the *Retina*, then the Object appears clear and distinct; if the Pictures on the *Retina* are confused, then the Object appears hazy and confused. This Account of the Eye, and the Cause of Vision, is farther confirm'd by these Arguments; that Anatomists, when they have taken off from the Bottom of the Eye, that outward and thickest Coat call'd the *Dura Mater*, can then see the Pictures of Objects lively painted on the *Retina*: And these Pictures propagated by Motion along the Fibres of the optick Nerves into the Brain, are the Cause of Vision. For, according as these Pictures are perfect or imperfect, the Object is seen perfectly or imperfectly. If the Eye be ting'd with any Colour, (as in the Disease of the Jaundice) so as to tinge the Pictures in the Bottom of the Eye with that Colour, then all Objects appear ting'd with the same Colour.

From hence we shall easily see the Use of Spectacles; for the Humours of the Eye decay by old Age, so as by shrinking to make the *Cornea* grow flatter than before, in which Case the Light will not be refracted

enough, and for want of a sufficient Refraction will not converge to the Bottom of the Eye, but to some Place beyond it; and by Consequence will paint in the Bottom of the Eye a confused Picture, and according to the Indistinctness of this Picture the Object will appear confused, just as the Image on the Paper became confused, when a Lens flatter than just, was substituted in the Room of the right one.

This is the reason of the Decay of Sight in old Men, and shews why their Sight is mended by Spectacles. For the convex Glasses supply the Defect of Plumpness in the Eye; and by increasing the Refractions make the Rays converge sooner, so as to convene distinctly at the Bottom of the Eye, if the Glass has a due Degree of Convexity, exactly in the same manner as the Defect of the too flat Lens was corrected, and the Picture render'd distinct, by placing a Spectacle-Glass of due Convexity before it.

And the contrary happens in short-sighted Men, whose Eyes are too plump; for the Refractions being now too great, the Rays converge and convene in the Eyes before they come at the Bottom; and therefore the Picture made in the Bottom, and the Vision caused thereby, will not be distinct, unless

less the Plumipness of the Eye be taken off, and the Refraction diminish'd by a concave Glass of a due Concavity, just as the Confusion of the Image occasion'd by the Use of too convex a Lens was remedied, by placing a Spectacle-Glass of a due Concavity before it.

This in general is the Manner in which the Defects of the Eye are remedied by the use of Glasses. But these Defects are neither the same in different Persons of the same Age, nor in the same Persons at different Ages. The Defects of the Eye are partly natural, and partly arise from Habits of looking either at very remote, or very near Objects; in the former Case we flatten the Eye a little, in the latter we draw it up into a more convex Form to see distinctly; and by Habit the Eye will acquire and retain that Form, and will have a fix'd Shape, either too flat, or too globular for Objects at a moderate Distance. We see this confirm'd by every Day's Experience, for Engravers, Watchmakers, Chasers, &c. by frequently forcing their Eyes into too convex a Form, to see minute Objects very near, at last have their Eyes fix'd in this Form, and become short-sighted, especially if they are used to these Businesses very young, while the Coats

of the Eye are tender and pliable. On the contrary, Sailors and Husbandmen, by looking out for distant Objects, are rarely or ever short-sighted, and want the Assistance of convex Glasses very soon, because the Habit of flattening the Eye to see remote Objects, at last fixes it in this Form.

From hence we may see that the Defects of all Persons Eyes will likely alter, according as they accustom themselves to such Habits as may either increase or diminish these Defects. Besides this, Age itself alters the Form of the Eye, making the Eyes of most Persons grow flatter, especially those who see well at a moderate Distance, when young Persons, naturally short-sighted, seldom find any considerable Alteration in the Eye; but when they do alter, I have observed that they oftener grow more short-sighted than otherwise.

Since therefore the Defects of the Eye, and the Glasses proper to remedy these Defects vary so much, both in different Persons and different Ages, I shall now lay down some Rules, by which every one may chuse not only good Glasses in their Kind; but such too, as are best suited to the Form and Shape of their own Eye. Every good Eye has one certain Distance (or nearly so) of

of seeing a common Print to read with Ease: When the Eye begins to grow too flat, you will find yourself obliged to hold your Book at a greater Distance; you may observe also, that if you read, write, or work any long Time, a sort of Dizziness like a Cobweb will appear before your Eyes, or if you read by a Candle you find it necessary to hold the Paper behind it.

These are Signs of the want of Spectacles, and whenever this appears to be the Case, no Person should be without them; for your Endeavours to see what you cannot without great Difficulty, strains and weakens the Eye, and by this you receive more Injury in a Month or two, than perhaps you otherwise would do in as many Years, with the Assistance of such Glasses, as would supply that Defect, and render the Vision distinct and easy.

The next Thing then to be considered is, what Degree of Convexity is sufficient to supply this Defect. In order to make a proper Choice, hold a small Print at the Distance, at which you was used to read distinctly, when your Eyes were good, which with most People is about nine or ten Inches, then chuse a Pair of Spectacles of such a Degree of Convexity as render the Letters

as plain as they used to appear before your Sight was defective; if you chuse them too young, *i. e.* not convex enough, they will scarce remedy the Defect of the Eye; and you will not see distinctly, unless the Print is so far off, that the Letters will appear too small to be read. If you chuse them too old, that is too convex, you will then be obliged to flatten the Eye to compensate the over great Convexity, and thereby be in danger of increasing that Defect, which Age naturally brings on.

But in many curious Pieces of Workmanship, there is an absolute Necessity of viewing the Object under a larger Angle, that the most minute Parts may be observ'd. In this case, Glasses of a larger Convexity may be used, and if the Work be brought nearer to the Eye, its Form will not be much altered, but the shorter time these Objects are view'd the better.

For short-sighted Persons, the best way is to look through a concave Lens at some distant Object, and the least Concave of all the Glasses, through which you can see it distinctly, is the best. I divide all my Glasses into 20 Degrees, mark'd 1, 2, 3, and so on. When a Person has fitted himself, I set down his Name, with the Number of the Glass

Glass chosen, which prevents any more Trouble of Tryal, or even going for it; but such Person may be supplied by sending a Servant or Letter, unless any material Alteration of the Eye should happen.

A Person whose Residence is in the Country, and has no Opportunity of making that Tryal, may nearly as well be fitted by the following Method; *viz.* Let the Person take a common Print, and move it to the Eye, till he sees distinctly, then measure the exact Distance from the Eye to the Paper: By sending an Account of that Distance to any Person in the Trade, they may be fitted to a sufficient Degree of Exactness.

I come now to point out the Defects of the Glasses themselves, and the way of discovering these Defects. Now these are either a false Figure, Veins in the Glass, or the Colour of it. And first for the Figure. Take any common Print, lay it on a Table, then hold the Spectacles in your Hand at a good Distance from the Eye, and looking through them, remove them gradually from the Paper, till the Spectacles are at the focal Distance from it, which in a convex Glass is somewhat nearer to the Print, than the Point at which it begins to appear confused. If the Spectacles are false, the Object through

the Middle of the Glass will appear regular and distinct, but through the Edges distorted and confused. Thus if you view any cross Lines, which form small Squares through a false ground Glass, the Squares in the Middle will appear with strait Sides, distinct, and all of a Size; but those near the Edges, with crooked Sides, of a different Bigness, and confused; so that the whole Appearance will neither be like the Original, nor all Parts of it distinct at the same Distance. If you view it through a true Glass, it will be perfectly like the original Figure, only bigger, and distinct in every Part. And as you gradually remove the Glass beyond the Focus, all Parts of the Object will become indistinct together.

To discover the Veins in convex Glasses, place a Candle from you about five or six Yards, then looking through the Glass move it from your Eye, till you fill it full of Light, and you will then discover every Vein and Speck in it. These Veins always distort Objects, and in the Object Glasses of Telescopes and Microscopes are especially mischievous, since all these Errors are much magnified by the Eye-Glass. Specks differ from Veins; for Specks are only small opaque Spots, which do not distort the Object,

ject, but only intercept an inconsiderable Part of the Light coming from it.

For the Colour of Glass, the whitest has been generally made use of for Spectacles, but I am inclin'd on many Accounts to prefer another Sort before it, or any other Material that has been made use of for this Purpose: For the common white Glass gives an offensive glaring Light, very painful and prejudicial to the Eyes; insomuch, that some advise green or blue Glass, tho' it tinge every Object with its own Colour, rather than this white Sort. That which I would recommend, is of a finer Composition than any commonly used; its Colour is the finest of any, and being a little ting'd with Blue, it takes off the glaring Light from the Paper, and renders every Object so easy and pleasant, that the tenderest Eye, may thro' it view any thing intently, without Pain. But, besides this, there are many other Reasons for rejecting the common white Glass, for 'tis of a softer Body than any other, and will not receive so true a Figure in the polishing, as a Glass of a harder Nature will, neither will the Polish itself be so fine and beautiful, nor of so long Continuance; for if it lies by any considerable Time, it will change to a reddish Colour,

hour, which is owing to the Nature of the Materials it is composed of; besides, this Sort of Glass is generally found to be very full both of Specks and Veins; insomuch, that one can hardly see any Spectacles made of this Sort of Glass that are free from it. That which I would here recommend is of an harder Nature, such as will receive a true Figure, and will take a very fine and high Polish, is perfectly transparent, and the freest of any from Veins and Specks. I have always found this much preferable to any other Sort, both in Telescopes and Microscopes, where the least Faults are discernable, especially in the Object-Glass, where every Error in the Image, they form, is greatly magnified by the Eye-Glass.

Brazil Pebbles, and Rock Crystal Stones are much cried up by some for Spectacles; they are indeed very hard, and therefore will take a true Figure and a good Polish; but, besides a glaring Whiteness, all these Stones have a Grain much like the Island Crystal *; and not only a Grain, but like that too, a double *Refraction*, so that all Objects appear double: Thus instead of one Letter there will appear two, one over the other. What Confusion this must occasion in

* See Sir Isaac Newton's Optics, Book 3. Quere 25.

in the Print of a Book may be easily guess'd at ; and tho' this is sometimes not great, so that the Letters are not much confused, yet it will occasion an Hazziness and Indistinctness, very like that of some Copper-Plate Prints, which have been moved a little on the Plate while they were printing off. If any one has a Mind to be fully satisfied of the Fitness of these Bodies for Spectacles, let him try to use them for the Object-Glass of a Telescope. Every one conversant in Opticks knows, the greatest Exactness in Figure, the most perfect Freedom from Veins, and the clearest Substances are always requisite to make a good Object-Glass in a long Telescope. But, if these Substances are so far from being preferable, that they are the worst of all others for that Purpose, so that it is scarce possible to make any Telescope at all with them ; they must, of Course, be the worst of all others for Spectacles too, tho' their Faults are not so easily discern'd in so simple an Instrument.

